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UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE

ANIMAL AGRICULTURE AND FOOD[1/]

INTRODUCTION

Livestock and poultry production accounts for a major part of the annual cash receipts from farming. It provides an effective way of utilizing land resources, a good way to upgrade a large part of the produce of the land into higher value food and fiber products, a significant part of the abundant food supply, and employment for many people.

The efficiency of livestock and poultry production--the outputs and the returns, as well as the quality and wholesomeness of animal products--depends in no small measure on the research that is conducted to develop new information and the application of this information on farms and ranches. The dynamic and challenging conditions that constantly confront livestock and poultry producers demonstrate the need for continuing and stepped-up research to provide the information needed to enable them to maintain a competitive position and to continue to supply consumers with adequate amounts of high quality animal foods.

The Long Range Study of Agricultural Research Needs [2/] for the first time has provided a satisfactory basis for examining how well these research needs are being met. The study also provides an outlook on the estimated needs for additional research in the different categories and among the different commodity groups over the next 10 years.

The Federal and State research inputs and projections given here, as they relate to animals and crops, are taken from the information in the Long Range Study report. The following material was developed and made available for the purpose of giving the readers, especially those interested and involved in livestock and poultry production, a basis on which to judge the adequacy of this research program as it relates to their interests.

Responsible officials as well as leaders in the agricultural community are sensitive to the needs of a dynamic and constantly changing industry. This statement is aimed at directing their attention to the (1) opportunity and challenge that exist for efficient livestock and poultry farming,

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1/ Developed by staff of the Animal Husbandry Research Division, ARS, USDA, Beltsville, Maryland.

2/ A National Program for Research in Agriculture, an Outgrowth of the Long Range Study of Agricultural Research, USDA, 1967.

(2) urgent need for expanded research to reduce the on-the-farm cost of producing animal products, (3) historical, as well as current, insufficiency in the support of livestock and poultry research, (4) favorable potential benefit-cost ratios possible from livestock and poultry research, (5) importance of livestock and poultry research to the total economy, and (6) the anticipated increased consumer demands for livestock and poultry products.

Historical

All through history man has maintained a close association with animals. He early found that by domestication he could use animals for his service and to meet his needs. He found them useful to ease the burden of labor in working the soil to produce food and to transport food and other articles from place to place. He further found them useful in transforming much of the produce from the soil that he could not utilize directly into marketable biologically nutritious foods. He found them useful to produce fiber for clothing and for other purposes. He also has cherished animals for the pleasure he derived from association with them and for recreational purposes. In every sense of the word man is a true lover of his animal friends.

Through domestication, man found that by development, supervision and management, proper nutrition, and housing he could effect an increase in the performance of the animals under his care. Organization of his animals into herds and flocks on farms and ranches, and the application of intelligent husbandry practices, resulted in increased production of meat, milk, eggs, and fiber, or increased capacity for work. As the human population increased, so did the animal populations. Markets for animals and their products developed. As a complex society developed, transportation systems, animal product processing plants, refrigeration services, marketing systems, service organizations, and related activities also developed. Together, these make up the orderly and efficient food chain we have today.

The discoverers and settlers of America brought their animals with them and used them to help create a new life in a new world. As the pioneers moved west, cattle and other animals accompanied and hauled them on their way. Dairying came in as the chinch bug drove wheat farming out of parts of the Midwest. The eastern cattle and the Longhorns, which descended from the Spanish cattle, populated the western ranges. The settlement conflicts and the fence wars of history involved competition between cattle and sheep ranchers in the West.

Animals thrived in America. On January 1, 1968, the livestock and poultry population totalled 86,582,000 beef cattle; 22,231,000 dairy cattle; 22,122,000 sheep; 54,263,000 hogs; 424,550,000 chickens;[3/] and 7,289,000 turkeys, all of which are kept for food and fiber production. In 1967 the cash receipts for farm marketings totalled $42.8 billion of which $24.4 billion, or about 57 percent, came from livestock and poultry. The value of livestock and poultry on farms on January 1, 1968, amounted to $18.7 billion.

3/ In addition about 2.6 billion broiler chickens were raised in 1967.

Animal foods in 1966 provided the following approximate percentages of nutrients to the national diet: food energy, 38; protein, 64; fat, 62; calcium, 82; phosphorus, 66; iron, 35; vitamin A, 30; thiamine, 36; riboflavin, 70; niacin, 43; and ascorbic acid, 6.

Animal foods are available in great variety, are of high biological value, are readily digestible, and are desirable in a well balanced diet. They effectively supplement food from plants by providing essential amino acids and other nutrients that make for good nutrition.

The USDA projection of needs in animal production by 1980 are for increases over 1964 of 39 percent for beef and veal, 12 percent for pork, 14 percent for lamb and mutton, 50 percent for chickens and turkeys, 18 percent for eggs, and 15 percent for milk--an overall average increase of 29 percent.

Animals and Food Opportunities in Developing Countries

America is blessed with an abundant and varied, high quality food supply. Many other countries of the world are not so fortunate, particularly heavily populated developing nations. These nations have not developed, or cannot develop, their agriculture to the point of feeding the population with basic essentials, much less an abundant varied diet. Protein is a principal lack but other nutrients, liberally contained in animal foods, also are lacking. Food production is not keeping pace with population increase in many areas. The availability of animal protein in the developing countries has been estimated at about 7 grams per capita per day compared with 42 grams in developed countries.

Solution of the food problem is the first concern of heavily populated developing countries. This also is the concern of food-affluent nations such as the United States. Food-deficit countries will find solutions first by developing their own agricultural resources and then finding ways to supplement deficiencies from supplies from countries that have food to spare.

The manner in which a nation goes about increasing food supplies is an important consideration. There is no doubt that land suitable for production of vegetables and grains, which can be used directly for food should be devoted first to these crops to the extent needed. This is, in fact, how it has worked out in this country.

There are vast areas of tillable land in most countries that do not have their best use in food crop production for a variety of reasons. These lands, together with lands not especially suitable for tillage, can and should be used for feed and forage for animal production, particularly for the ruminant.

Some people think that animal production is obsolete because it is too inefficient in use of resources in terms of feeding the hungry world. No one country can or should attempt to feed the hungry world. It may assist, and

assist greatly, but the first requirement is to utilize agricultural resources to satisfy the needs and desires of its own people.

In the United States the people appreciate, desire, demand, and will pay for increasing quantities of a variety of high quality animal foods. They should have them. It is the obligation of agricultural leaders to see that conditions are such that American farmers can produce at a profit the amounts and kinds of animal foods the people want and need for a nutritious balanced diet.

Animal Production Challenged Because of Low Efficiency

The challenge that animal production should be discounted is based on the knowledge that the efficiency of conversion of energy and protein in crops when passed through the animal is low.

Table 1 shows that the energy conversion from feed to animal product varies from 6 to 20 percent and the protein conversion rate is from 10 to 30 percent by the different species.

TABLE 1.--Percent of feed nutrients and feed consumed converted to edible products by animals 1/

Animal product	Energy	Protein	Gross edible product as percent of feed intake
	Percent	Percent	Percent
Milk 2/	20	30	90
Beef	8	15	10
Lamb	6	10	7
Pork	15	20	30
Eggs 2/	15	20	33
Chicken (Broiler)	10	25	45
Turkey	10	20	29

1/ Byerly, T. C., Cooperative State Research Service, USDA, Sixth FAO Inter-American Conference on Animal Production and Health. Gainesville, Florida, September 1967.

2/ An additional residual quantity of energy and protein is contained as meat in carcass after productive life is ended.

It is inappropriate to base decisions on the future of animal agriculture solely on the basis of protein and energy conversion of crops that may be used directly as human food. There are other well known reasons why animal production is highly important in the effective and balanced utilization of agricultural production. Some of these reasons are briefly mentioned.

A Strong Animal Agriculture Is Needed

Animal foods make their important contribution to a nutritionally adequate diet, particularly in the amino acid content of the protein. Science is learning how to supplement plant protein to make it more biologically adequate so that less dependence need be given to inclusion of animal foods in the diet. However, people like animal foods such as beef, poultry meat, pork, eggs, lamb, milk, cheese, and other dairy products. These foods add not only to the quality of the diet, but also to the pleasure of good eating and living.

But there is much more than this to justify a strong viable animal agriculture. Animal production provides a ready and orderly way of upgrading and providing a market, as food and fiber, for a huge portion of the product of the soil that otherwise would not have a market. Animal production provides in a similar way a market for great quantities of grain and grain byproducts and oilseed byproducts that are not now, nor will they be in the foreseeable future, needed or used for direct human use. What position would the feed grain and oilseed producers and processors be in if it were not for a market through livestock for the feed grains, byproducts, and oilseed meals?

Animal production offers a granary for significant reserves of food that can be marshalled in time of emergency. Animal production provides work and a satisfying way of life for large numbers of people both rural and urban. It provides employment for many people working in numerous industries that in one way or another are required to service producers of animals and animal products, and to those employed in processing, marketing, and distribution systems. The capital required in the total production, processing, servicing, and marketing systems represents a large investment indeed.

Animals Are Large Users of Land Resources

In the United States, according to the 1964 census, 63 percent of the 1,110 million acres of land in farms was used for pasture and the production of hay and corn silage. One quarter of the 1,161 million acres of land not in farms was used for grazing. The produce of these lands is used for feeding animals, mainly cattle and sheep.

Farm livestock and poultry in 1965 consumed 376.3 million tons of feed units (one feed unit equivalent to one pound of corn). About 54 percent came from pasture, hay, and other harvested forage. Only 8.6% came from protein rich concentrates. For beef and dairy cattle and sheep (ruminants) the consumption from forages averaged 73% of total intake, with only 4.5% coming from high protein concentrates. Poultry and hogs consumed 96% of their feed units from concentrates. Almost 20% was from high protein concentrates.

Total concentrates consumed in 1964 by all livestock and poultry amounted to 96.4 million tons of corn, 14.4 million tons of sorghum grains, 22 million tons of other grains, 18.3 million tons of high protein feeds, and 12.4 million tons of byproduct feeds, a total of 163.6 million tons.

The milk cow is the most efficient converter. This is important because the milk cow is able to obtain a high percentage of the energy and protein needed from feeds not edible by man.

For example, table 1 shows that the dairy cow is 30 percent efficient in converting protein from feed to milk. This table does not specify the sources of feed protein. About 70 percent of the feed protein normally fed to milk cows comes from forages. Further, the table does not take into consideration that the feeding of nonprotein nitrogen and various byproducts can and do provide important sources of protein that are not usable by man.

It has been shown that for cows on typical concentrate-forage rations the equivalent of 96 percent of the protein fed in grains and oilseed products is returned in the milk. These grains and oilseed meals are the only parts of the ration which could be used directly by man. The milk protein is of higher biological value than that fed. Further, if urea, a nonprotein nitrogen, is fed at the recommended levels, the return in milk protein exceeds the protein input from grain and oilseed meals by 40 percent.

Beef cattle and sheep are lower in their conversion rates than milk cows. However, they are even less dependent on grains and oilseed meals and more on forages for their sustenance. Since these species can also use nonprotein sources of nitrogen for tissue protein production the conversion ratios can be greatly improved over those indicated in table 1, as far as products that can be used by humans are concerned.

There are large quantities of byproduct feeds resulting from the processing of grains, vegetables, fruits, etc., for human use. In addition, large tonnages of straw, not now effectively used in any way, provide a potential source of feed for ruminants. These materials when properly processed and effectively supplemented with nonprotein nitrogen and other additives may provide important sources of feed for cattle and sheep, and thus serve as a replacement for important quantities of grains and oilseeds meals.

In spite of the relative efficiencies of the different species of farm animals in converting protein and energy from feed to animal products, and in spite of the differences in sources of feeds for production in relation to possible human use competition, consumers are turning more to beef and poultry meat and less to milk and pork in satisfying their food needs. The per capita consumption increase 1950 to 1966 is: beef and veal, 52%; chickens, 75%; turkey, 90%. The decrease is: pork, 16%; lard, 39%; milk (equivalent of all milk and milk products), 18%; and eggs, 20%.

The National Interest in Animal Agriculture

The relatively low efficiency of animals in converting raw material into food energy and protein appears to be cause for concern. In view of the high appreciation that nutritionists and the consumer place on animal foods in the national diet, it ought to be national policy to do what is necessary to develop the needed information to enable livestock and poultry producers to increase this efficiency. Significant improvements have been made over the years but progress has not been fast enough or great enough. Improvement in efficiency of feed conversion in livestock production is important from the standpoints of (1) more effective use of the nation's food and feed resources, (2) greater returns over input costs to the producer, and (3) larger quantities of high quality nutritious animal products at reasonable costs for the consumer.

Animal Efficiency Has Not Kept Pace With Crop Efficiency

Table 2 shows the increase in production per unit for a number of important crops and animal products, 1950-1966. With few exceptions food and feed grain crop yields have made greater increases per unit, a measure of increased efficiency, than have animal yields. Note that the unit production of the hay crop, an important animal feed, has not increased like that for grain crops.

Research for New Technology

It should be useful to examine some of the reasons for this difference in rate of progress. It is generally considered that progress is largely due to the development of new technology and the wide-scale application of this technology to practice on farms and ranches. A very large part of the new technology comes from the public supported research laboratories and stations operated by the State universities and the U.S. Department of Agriculture. This research is importantly supplemented by research programs supported by various kinds of industrial organizations and firms. Since science knows no national borders, some of it has come also from foreign institutes.

On examining our national research program, it is useful to look at the scientific man-year inputs for animal research and for crops research in the State and Federal support programs. A good source of information

TABLE 2.--Progress in improving yields per acre in crops and yields per unit of livestock and poultry, 1950-1966 1/

Item	Increase
	Percent
CROPS	
Barley	40
Cotton	80
Corn grain	88
Grain sorghum	148
Hay	34
Oats	29
Peanuts	88
Peas, green (Processing)	13
Potatoes	37
Rice	82
Rye	80
Soybeans	18
Sweet corn (Processing)	54
Tobacco	60
Tomatoes (Canning)	98
Wheat	60
LIVESTOCK AND POULTRY	
Breeding unit - Production (average for all livestock and poultry)	2/ 37
Eggs - number produced per hen	25
Milk - pounds produced per cow	60
Beef - liveweight produced per cow (estimated)	26
Broilers - liveweight produced per feed unit	2/ 18
Hogs - pigs raised per litter	14
Hogs - reduction in pounds of lard produced per pig	23
Sheep - liveweight produced per ewe	13
Sheep - wool produced per sheep shorn	3
Sheep - lambs born per ewe	6

1/ U.S. Department of Agriculture. Agricultural Statistics, 1967. 758 pp. 1968.

2/ U.S. Department of Agriculture Statis. Bul. 233, 17 pp. 1968.

is found in the report on "A National Program for Research in Agriculture, an Outgrowth of the Long Range Study of Agricultural Research," published in 1967 by the U.S. Department of Agriculture; also, the associated Inventory of Agricultural Research, Volumes I and II.

Study of Agricultural Research Needs

The Long Range Study was made at the request of the Congress to the U.S. Department of Agriculture for a determination of the needs for agricultural research over the next decade. The report was produced from a detailed study made by joint committees of State and Federal agricultural research specialists and administrators. In-depth studies were made of the current research input in terms of scientific man-years (SMY) 4/, the identification of problem areas needing increased or new attention and an estimate of the SMY needed to make real progress towards their solution. One of the first tasks of the study groups was to determine the SMY inputs on various problems and for various commodities and services that made up the State-Federal research program in agriculture. From this base, projections were then made of the inputs needed in the several identified areas over the next 10 years.

Research Inventory

From these data the research effort that goes into solution of problems relating to animals and crops can be ascertained. But a clear separation of the research on animals and crops is not easy, because of the overlapping and integration of activities of scientists in specific research projects. Research input on plants such as feed grains, forage, and range applies also to animal production. For the research inventory, therefore, the inputs can be summarized under broad classifications of activity, namely, protection, production, and all other.

The summarization for SMY inputs for animal research and plant research for fiscal year 1967 (July 1, 1966, to June 30, 1967) is given in table 3. The corresponding dollar input is also given.

4/ Scientific man-year(s) (SMY) includes research workers at State experiment stations who have a rank of Assistant Professor or above, or GS-11 and above in USDA.

TABLE 3.--Summary of scientific man-years (SMY) and funds (including overhead) expended on research in fiscal 1967 by the USDA and State agricultural experiment stations (SAES)[1/]

Research Area	SMY		Total funds expended	Fund sources		
	Total	ARS contract [2/]		Federal research appropriation	Federal & CSRS administration	Other [3/]
	Number	Number	Million dollars	Million dollars	Million dollars	Million dollars
PLANT [4/]						
Protection:						
USDA	618	---	25.6	25.6	---	---
SAES	915	(52)	31.5	2.0	7.4	22.1
Total	1,533	(52)	57.1	27.6	7.4	22.1
Production efficiency & product quality:						
USDA	483	---	18.9	18.8	---	---
SAES	1,515	(18)	52.8	.7	9.0	43.2
Total	1,998	(18)	71.7	19.5	9.0	43.2
All other:						
USDA	734	---	27.3	27.3	---	---
SAES	304	(87)	11.2	2.2	2.8	6.2
Total	1,038	(87)	38.5	29.5	2.8	6.2
Totals by agency:						
USDA	1,754	---	68.9	68.9	---	---
SAES	2,671	(157)	93.5	4.9	17.1	71.4
Total	4,425	(157)	162.4	73.8	17.1	71.4
ANIMAL						
Protection:						
USDA	252	---	18.6	18.6	---	---
SAES	378	(8)	15.9	.4	2.7	12.8
Total	630	(8)	34.5	19.0	2.7	12.8
Production efficiency & product quality:						
USDA	116	---	7.8	7.8	---	---
SAES	933	(5)	46.7	.2	8.4	38.0
Total	1,049	(5)	54.5	8.0	8.4	38.0
All other:						
USDA	236	---	8.6	8.6	---	---
SAES	228	(14)	8.3	.4	3.0	4.9
Total	464	(14)	16.9	9.0	3.0	4.9
Totals by agency:						
USDA	604	---	35.0	35.0	---	---
SAES	1,538	(27)	70.9	1.1	14.1	55.8
Total	2,142	(27)	105.9	36.1	14.1	55.8

1/ From "An Inventory of Agricultural Research," Vol. II, USDA. Oct. 1967.
2/ Supported by ARS contract, grant, and Cooperative Agreement funds. Included in SAES totals but not in USDA totals.
3/ State appropriations and other funds available to SAES.
4/ Does not include forestry or ornamental research.

From these data it is possible to develop the following ratios of support for research between animals and crops for the different broad classifications.

I Science Man-Year (SMY) Ratios:

(a) Crops Research to Animal Research:	
State and Federal combined	2.1 to 1
(b) Crops to Animals:	
States	1.7 to 1
(c) Crops to Animals:	
Federal	2.9 to 1

II Dollar Support Ratios:

(a) Crops Research to Animal Research:	
State and Federal combined	1.6 to 1
(b) Crops to Animals:	
States	1.3 to 1
(c) Crops to Animals:	
Federal	2.0 to 1

III Science Man-Year (SMY) Ratios:

(a) Animal Protection Research to Animal Production Research:	
State and Federal combined	0.6 to 1
(b) Animal Protection to Animal Production:	
States	0.4 to 1
(c) Animal Protection to Animal Production:	
Federal	2.1 to 1

IV Science Man-Year (SMY), Percent Federal is of total:

(a) Animal Protection	40%
(b) Animal Production	11%
(c) Crop Protection	40%
(d) Crop Production	25%

V Cash Receipts from Farm Marketing 1966:

Total ($ billion)	43.2
Livestock and Products ($ billion)	24.8
Crops ($ billion)	18.4
Percent from animals	57.4

Farm Research Support in USDA

Support for the farm research program of the U.S. Department of Agriculture comes from annual appropriations made by the Congress. These appropriations reflect, to a major extent, the recommendations of the Executive Branch and the actions of Congress. A summary of appropriations to the divisions of the Agricultural Research Service for their research programs for fiscal years 1956 and 1968 and of increases between these two years is given in table 4.

TABLE 4.--Fund support for farm research conducted by divisions in the Agricultural Research Service, USDA

Division	1956	1968	Increase	Av. increase/ yr.	Share of farm research fund 1/
	Million dollars	Million dollars	Percent	Percent	Percent
Agricultural Engineering	1.8	6.1	250	20.8	6.5
Animal Husbandry	4.2	8.7	105	8.8	9.3
Animal Disease and Parasite	4.4	14.8	236	19.7	15.8
Crops	10.3	29.5	188	15.7	31.4
Entomology	4.4	17.6	304	25.4	18.8
Soil and Water	3.9	17.1	338	28.2	18.2
Total	28.8	93.9	225	18.8	100.0

1/ Fiscal Year 1968.

These data suggest that animal husbandry research has not fared well in appropriations nor in the increases that have been granted over the past 12 years. The average increase per year for animal husbandry has been 8.8 percent as compared to 18.8 percent for all farm research in the Department of Agriculture. Much of the animal husbandry increase has been earmarked for work on pesticides residue and health related production research. During these years it is estimated that increases amounting to about 7 percent per year were required just to meet increasing costs of doing research.

Long Range Needs for Science Man-Years

As a part of the long range study, projections were made for increases in SMY over the next 10-year period. These projections, together with the allocation of the number of different commodities, the areas of research, and the distribution between Federal and State, were made by a committee of Federal and State agricultural research administrators. The 1966 SMY base with the present distribution of SMY between Federal and State was used. This is shown in table 5.

TABLE 5.--Distribution of research effort between USDA and State agricultural experiment stations by broad groupings1/

Group	1966		
	Total SMY	Percent USDA	Percent SAES
Forestry	1,164	66.7	33.3
Soil, Water, Watershed, Pollution	948	50.0	50.0
Agricultural Engineering	281	26.7	73.3
Entomology	776	48.6	51.4
Animal Disease	558	35.3	64.7
Livestock and Poultry Production	985	10.1	89.9
Horticultural Crop Production	1,160	16.0	84.0
Field Crop Production	1,693	30.1	69.9
Food Science and Utilization-Livestock	378	55.0	45.0
Food Science and Utilization-Fruits & Vegetables	326	52.8	47.2
Food Science and Utilization-Field Crops	592	80.2	19.8
Food Safety	177	46.6	53.4
Production Economics	219	42.0	58.0
General Economics	287	57.5	42.5
Rural Development	200	36.5	63.5
Marketing Efficiency	350	49.7	50.3
Foreign Trade and Program Evaluation Expansion	92	87.0	13.0
Consumer Oriented	254	31.1	68.9
Totals	10,440	41.1	58.9

1/ Summary of actions of Joint Federal-State Committee on Agricultural Research Planning. Long Range Study of Agricultural Research Needs. USDA. July 1967.

Table 6 shows the 10-year projections and the percent increase in SMY recommended. The increase for animal production is 44%; animal diseases, 75%; and field crop and horticultural crop production 58% and 62%, respectively. Consequently, if this plan is followed, the gap between animal research support and crop research support, and that between animal protection and animal production will be even wider in the future.

TABLE 6.--Ten-year projected increases in research by broad groupings 1/

Group	1966 Base SMY's	Ten-year Projected Increase in SMY's	Increase Percent
Rural development	200	425	213
Foreign trade and program evaluation expansions	92	146	160
Production economics	219	276	126
Soil, water, watershed, pollution	948	1,048	112
Consumer oriented	254	257	101
Food safety	177	165	93
Forestry	1,164	1,048	90
General economics	287	225	29
Animal diseases	558	420	75
Horticultural crop production	1,160	982	62
Agricultural engineering	281	162	58
Field crop production	1,693	982	58
Entomology	776	405	52
Livestock and poultry production	985	439	44
Food science and utilization-fruits and vegetables	326	158	42
Marketing efficiency	350	121	35
Food science and utilization-livestock	378	96	26
Food science and utilization-field crops	592	133	23
Totals	10,426	7,238	70

1/ Summary of actions of Joint Federal-State Committee on Agricultural Research Needs. USDA. July 1967.

Science Man-Year Inputs Related to Farm Income

What is the relative SMY support for animal research and crop research compared to the value of products derived from animals and crops?

Sales of livestock and livestock and poultry products regularly provide well over half the cash income of American farmers. If value of products is taken as one criterion of justifiable research expenditure, it does not follow that more than half the total research effort should be on livestock and poultry. Animals consume a high percentage of the nation's crop production. Research on soils, water, and other natural resources support both crop and animal production.

A meaningful relationship, however, may be a comparison of research effort on animals with the research effort on the principal nonfeed crops, for example, those raised principally for direct human consumption and other needs.

Table 7 shows the SMY inputs (both Federal and State) in relation to value of principal nonfeed crops and of animal products.

In 1966 there were 294 SMY per $1 billion of food crops and related products and only 92 SMY per $1 billion for animal products. This difference in expenditures and the realization of the high cost of research on large animals may help to explain the proportionately greater improvement in efficiency of production of those food crops compared with that of livestock. A single wheat plant, for example, yields as much genetic research data as one cow. A crop plot of a few square feet is as valuable for agronomic information as 10 steers are for nutrition research.

Some Potential Benefits From Animal Research

Research in the several problem areas of the group classified as animal production efficiency offers significant opportunity to increase the overall efficiency of livestock and poultry farming. A number of examples of the potential benefits from the solution of problems are given:

Improved Reproduction Performance.--Significant losses in all farm species occur due to reproduction inefficiency. These losses are in addition to those caused by infectious agents and are characterized as physiological. They are expressed as low calf, lamb, and pig crops, and low hatchability of eggs, and they are caused by many factors. Concentrated research attack on the numerous causes of delay or failure in breeding, death of embryos, weak or dead young at birth, and similar research, over the next decade could significantly reduce these losses and return large benefits to producers.

TABLE 7.--Research effort and value of product for principal nonfeed crops and for livestock 1/

Type of crop or livestock	1966 Research effort (SMY's)	1966 Farm value of product
CROP	Number	Million dollars
Citrus and other subtropical fruits	252	525.6
Other fruits	539	963.9
Potatoes	136	625.4
Vegetables	565	1,593.9
Rice	44	405.4
Wheat	295	2,142.2
Cotton	498	990.7
Cottonseed	55	261.0
Tobacco	162	1,254.4
Sugar crops	139	376.1
Total	2,685	9,138.7
SMY per billion dollars of product = 294		
LIVESTOCK		
Poultry and eggs	478	4,142.7
Beef Cattle	540	2/ 7,853.5
Dairy Cattle	596	3/ 5,784.7
Swine	233	4,353.5
Sheep and wool	214	360.8
Total	2,061	22,495.2
SMY per billion dollars of product = 92		

1/ U.S. Department of Agriculture. Agricultural Statistics, 1967. 758 pp. 1968.

2/ All cattle and calves including "byproduct" dairy animals.

3/ Dairy products only.

In addition to reducing the incidence of reproductive failure the opportunity exists to increase the numbers of young produced per sow, per ewe, and per beef cow which would significantly increase the production per breeding unit. Likewise, research that would enable one to predetermine or regulate the sex of offspring would add greatly to the benefits to producers of meat producing animals. The ability to manage and manipulate both male and female germ plasm in a number of different ways would aid materially in utilizing artificial insemination and possibly other techniques in improving not only the reproduction performance, but also the efficiency of production and the quality of various animal products. These opportunities await only the scientific effort to bring about their solution.

The consequence of these deficiencies has been estimated to cost the livestock and poultry producers the sum of $3 billion per year.

Improvement in Feeding Efficiency.--One of the greatest opportunities to bring about increased efficiency in animal performance with lowering of costs is in the area of nutrition and feeding. Feed is the largest single cost in animal production. Except for broiler and egg production, the amount of feed units consumed per unit of production has shown little or no change for the past two decades. There is large opportunity to improve this situation by (1) improving the knowledge of the specific nutritional requirements of various animals for specific functions; (2) constructing new feeding standards based on net energy systems; (3) improving the yield, saving the nutrients grown, and improving the acceptability of forages of all kinds as feed for ruminants; (4) improving methods of evaluation and using feeds and feed ingredients, feed additives, etc.; (5) developing through genetic and breeding systems animals with the ability to consume more feed and digest and metabolize nutrients to a higher degree; and (6) developing more efficient and less costly management systems for handling feed of all kinds and for caring for farm livestock and poultry, including management of waste.

Nutritional and feeding regimes, range, farm lot, and feed lot management, rationing systems, etc., need to be investigated with the view of promoting fast gains and early marketing of the kinds of animals that yield desirable carcasses of meat. New feed additives must be found and evaluated; the use of nonprotein nitrogen and low grade roughages and byproduct materials must be developed to furnish low cost sources of nutrients and accelerated production.

The potential benefits to be derived from this kind of research on livestock and poultry are estimated to be about $5 billion annually.

Improve Quality and Assure Safety in Animal Products.--In the meat producing animals high attention must be given to better pattern the quality of the product to the needs and desires of the consumer. This must be accomplished mainly through production methods. Meat that is tender, juicy, and appealing without excess fat around and in the tissue appears to be the objective. How do farmers and ranchers produce animals that yield this kind of meat?

Better tools are needed to identify yield and quality characteristics in the carcass as well as in the live animal. Breeding and selection information must be available to guide producers in the development of reproducer herds that will furnish these kinds of animals to the market. Ways must be found to structure breeding herds that will furnish the seed stock for production of the kinds of animals that will perform efficiently in the finishing systems of animals for marketing. Evaluation of breeds, breeding systems, crossing, value of exotic stocks, and heritabilities must be accomplished in the laboratory. Animals with ability to withstand the stress of intensive production must be developed.

As new techniques and practices in feed production and animal feeding and management are developed and put into use, they must be managed so that the resulting animal product is wholesome and free of potentially harmful residues. Research must not only find out what chemicals, feed additives, etc., can be used in the efficient and economical production of animal products, but also how they can be used with the result that the product is wholesome and safe for human food. These are but a few of the opportunities that await solution by the research scientists to benefit the livestock and poultry producers. Potential benefits that could be derived from these areas of research are about $2 billion annually.

The composition and flavor characteristics of milk are subject to alteration by feeding and genetic methods. Research can change these characteristics to make milk more appealing to the consumer and more competitive in the market place. Likewise, the quality of eggs and poultry meat can be improved to benefit both the producer and the consumer.

Increased research effort is needed to guard against the possible presence of residues and other contaminants that might occur in animal products arising from the use of chemicals and other materials and from practices used in agricultural and animal production. Likewise, increased attention must be given to the management of animal waste, that is the byproduct of animal production, so that it does not pollute the soil, water, and air environment with hazardous or undesirable contaminants.

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